Sacred Soil: A Place of Origin

Developed by:
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Time
75 minutes

Location
Station 2

Group
4-8 Students

Subject Areas
Natural Sciences

State Standards
MS-LS2-1: Interdependent Relationships in Ecosystems Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.

Concepts
Soil structure, plant nutrients

Materials
- ❏ Electronic pH tester for soil
- ❏ 5 Clear jars containing organic material, topsoil, subsoil, clay, and rock
- ❏ Sit pads 1 per student
- ❏ Journals
- ❏ Pencils

Overview:

This lesson introduces middle school students to the important role of soil in forest ecosystems. Our activity focuses on soil characterization which is a part of long term ecological research (LTER) projects that are ongoing at HJ Andrews Experimental Forest.

Learning Outcomes:

By the end of this activity, participants will be able to:

1. Articulate the 5 major components of soil, (air, water, minerals, organic material, and microorganisms)
2. Name the 4 macronutrients that are important for healthy soil.
3. Describe the connection between fertile soil, healthy plants, and clean air and water.

Rationale:

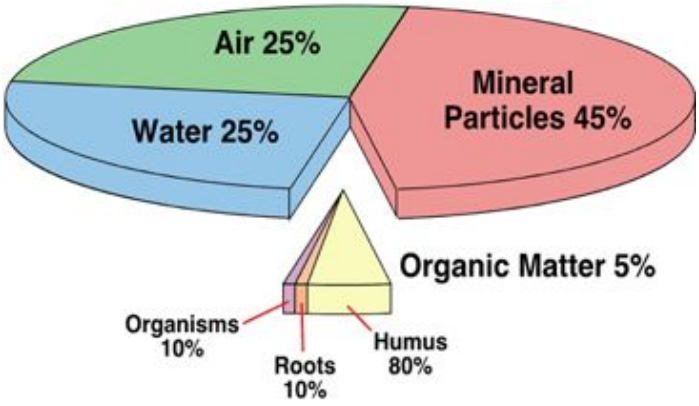
In this lesson, students will learn the physical makeup of the soil beneath their very feet! Soil is the foundation of life on land, and is the fundamental element that allows terrestrial beings to flourish. Students will gain valuable knowledge about soil nutrients and where the nutrients form in an old growth forest. Throughout the lesson students will learn why healthy soil improves the wellbeing of plants, animals, and people. Nutrient rich soil is full of microorganisms, minerals, air, water, and organic material. These five essential ingredients are responsible for the growth of the huge Douglas-fir trees found in HJ Andrews, as well as all the other plant life which thrives there. Healthy plants are able to remove toxins from the air and water by efficiently absorbing pollution. Learning about all that soil provides is a great way to form a bond between students and the places they live and visit. Forming this connection is a powerful way to encourage proper stewardship of the land we rely on so much.

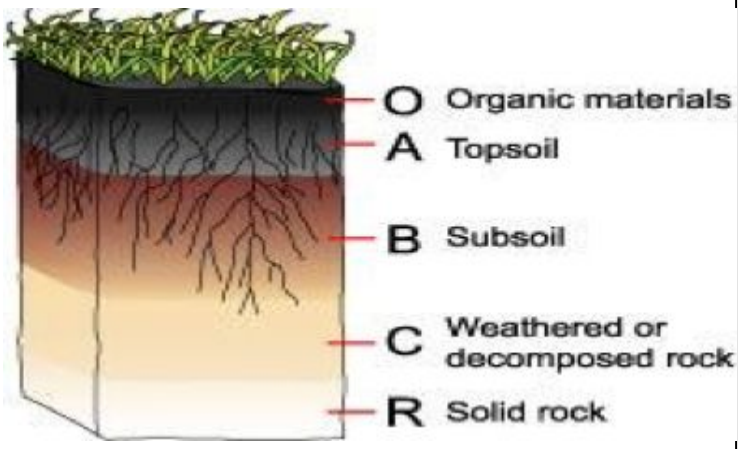
Background:

Soil contains the nutrients that plants need to grow. It has the amazing ability to anchor plant roots to the Earth, and provides a habitat for billions of microorganisms. Healthy soil that supports the most plant growth is comprised of 5 main parts, some of them organic, (living) and some of them inorganic, (non-living). The organic parts make up only 5% of the total soil volume. Organic material includes things like dead animals, leaves, sticks and microorganisms. The term humus, (Say “hew-mis”) is used to describe the decomposed plant and animal matter that is rich with nutrients. The inorganic parts make up 95% of the soil volume. The inorganic parts include water, which makes up 25%, air 25%, and minerals 45%.

If we focus on the largest piece of the pie, the 45% mineral piece, we learn that it is made up of 3 potential parent minerals. These are sand, silt, and clay. A ratio of 40% sand, 40% silt, and 20% clay makes up an ideal soil mixture to support plant growth. This ideal mixture is known as loam. The important inorganic plant nutrients are formed during the decomposition of organic material and their names can be found on a periodic table of the elements! The primary macro nutrients that are important for soil fertility are Nitrogen (N), Phosphorus (P), Potassium (K), and Calcium (Ca). Nitrogen is a part of all protein and living cells.

N increases leaf area which means more photosynthesis and more succulent and dark green leaves. If there is too much nitrogen, it will delay the ripening of fruit, weaken plant stems, and make the plants more susceptible to pests. P promotes balanced healthy growth. It enhances strong root development, flower and seed formation, and promotes vigor and disease resistance. K is good for all around plant health. It balances nitrogen and phosphorous. Ca builds cell walls and promotes the growth of beneficial bacteria.





A soil profile boiled down to its basic form consists of 5 common layers denoted by the letters O, A, B, C, and R.

- **O- Organic** material aka leaf litter. This is the **uppermost layer** of soil and the one visible to the eye. This layer includes things found on the forest floor such as twigs, leaves, decaying plants and animals.
- **A- Top soil layer**. This is a layer rich in nutrients, where plant seeds germinate and begin to grow. Roots penetrate this layer.
- **B- Subsoil layer**. This layer contains a mix of broken down rocks with a small amount of organic material. Some plant roots venture into this layer because it is home to many minerals.
  - Most of the plant activity occurs in the A layer and the upper portions of the B layers, however the lower levels of soil form a foundation upon which the upper layers form.
- **C- Weathered Rock Layer** that lacks organic materials. This is a very rocky and clay like layer that is less permeable than the upper layers. Plant roots rarely will reach this deep into the soil.
- **R- Rock Layer**. this is the layer that is at the **very bottom** of soils. The bedrock layer.

A pH value is a number from 1 to 14 that describes the acidity or alkalinity of a solution or soil. A pH of **less than 7** is **acidic** and a pH of **more than 7 is alkaline**. A pH of **exactly 7 is known as neutral**. pH is important because different plants prefer different pH levels. An easy way to remember this is by thinking of people swimming in a pool. One person will most enjoy swimming in very warm water, while another may prefer it to be cooler. Similarly, plants species have a preferred pH level. Some species may prefer slightly acidic soil, while others prefer slightly alkaline. Plants are resilient and can grow well in a range of pH levels, but it is worth remembering that there is an optimal pH range for each species of plant to reach peak growing potential.

Activity 1- Build a soil profile

Time

35 minutes

Concepts

Soil Structure and Plant Nutrients

Materials

- ❏ Electronic pH tester
- ❏ 5 jars containing organic material, topsoil, clay-base, clay, and rock
- ❏ Plastic cutting board

Step 1: Gather students in a circle around the soil jars. Use the same sitting materials from the sit spots for students to sit or kneel on.

Describe the work that H.J. Andrews undertakes regarding soil. Currently their work and research consists of:

o Identifying and mapping soil types within HJA in order to produce a standard soil survey that will be placed within the US system of soil taxonomy

o Nitrogen fixing potential of soil

o Dr. Elizabeth Sulzman. Dept. of Crop and Soil Science, OSU studies the carbon storage potential of soil

o Connections between forest harvesting and erosion

*Frame the activity as doing the same work that HJA researches are performing:

o "Today we are going to examine some soil samples and describe their characteristics before they get mapped, just like the real HJA team. To do this, we are going to examine soil profiles. Soil profiles are stacked vertical layers of soil with unique characteristics"

Step 2: Examine jar 1

Open the jar and pass it around between students,

- Ask students to make an observation about the contents just from looking at the materials.
- Have the students take turns holding and smelling the materials.

Have students verbally share their observations.

Step 3: Ask these questions about jar 1.

Q: How do plants and animals at the surface interact with soils?

A: Plants and animals take up nutrients to fuel their activity, and when these organisms die they decompose so other plants and animals can use their nutrients. This nutrient cycle is important for a sustainable ecosystem where there is a balance between nutrients supplied and nutrients demanded.

Q: What type of things break down plants and animals on the forest floor?

A: Fungi, algae, lichens, microorganisms, cyanide millipedes, other insects.

· When students are finished examining materials, pour materials back into jar.

Step 4: Repeat step 2 with jar 5, then ask these questions.

Q: Where do you think the rock layers are located within soil profiles?

A: The bottom, think of Earth's crust.

Q: What role does the rock layer have in soils?

A: Rock provides parent material; when rocks erode soil forms from small pieces of the original rock. Roots of the old growth trees help to create soil by breaking up the parent material into smaller parts.

- When students are finished examining materials, pour materials back into jar.

Step 5: Repeat step 2 with jar 2, then ask these questions.
Q: This jar smells much more than the other samples, why do you think that is?
A: High organic material content.
Q: What characteristics stand out in this sample?
A: Highlight the small pieces of bark and dark color, signs of high organic material. Also highlight the fluffiness, which is important for allowing air and water through.
Q: Why does it matter if air and water can move through soil?
A: allows for roots to grow and absorb nutrients and water.
When students are finished examining materials, have students pour material back into jar.

Step 6: Repeat step 2 with jar 4, then ask these questions.
Q: How would you describe the texture from this sample?
A: This is a thick rock layer, this has to do with soil sticking together and clumping.
Q: How does thick and clumping soil affect plant growth?
A: More difficult for water and roots to pass through it, difficult to grow many healthy plants.
Q: This sample is lighter in color than the black jar, why do you think that is?
A: Lower organic material.
- When students are finished examining materials, pour materials back into jar.

Step 7: Repeat step 2 with jar 3, then ask these questions.
Q: Does this sample look familiar?
A: It should, this is called a subsoil layer that is often the middle ground between rich topsoil and very rocky clay filled soils, containing characteristics of layers on top and below it.
Q: What do you think happens in this layer?
A: Only very large and strong plants have root systems in this layer; it mostly acts as a middle ground
- When students are finished examining materials, pour materials back into jar

Step 8: Once all jars have been shown, have students balance the jars on top of each other in order to create a soil profile.
· The correct order on the tops of the jars 1-5
o If students fail to get order correct, explain to them that soils typically have lower nutrients and air content as you go down

Step 9: Ask the students, "Do you know any other factors that influence plant growth?" Bring up the concept of pH.
· Ask for a student to define pH, (A measurement of how acidic or alkaline something is).
· Ask for a student to describe how pH might affect plant growth in soil, (Specific plants prefer a specific range of pH levels in order to maximize their growth).
Explain that pH can be tested with an electronic machine like the one we have.
· Pass around the pH testing device so all the students can examine it.
· Insert the device into the soil and wait 60 seconds for it to measure.
Have the students examine the measurement to determine if the soil is more alkaline or acidic.

Step 10: Assess understanding by,
· Have students write down the 5 essential components for a healthy soil
· Take a survey of the students who know the proper layering of a soil profile by:
o Ask students to hold up a number between 1 and 5 on their fingers, 1 being the top most layer and 5 being the bottom. Ask, "which layer is topsoil?" (2), "Which layer is Organic matter?" (1), "Subsoil?" (3), "Rock?" (5), "Clay?" (4).

Activity 2: Sit Spot and Journaling

Adapted from: Haas, Ellen, Richard Louv, Evan McGown, and Jon Young. *Coyote's guide to connecting with nature*. Shelton, WA: OWLink Media, 2010. Print.

Time

25 minutes

Concepts

Sensory Awareness, Mindfullness

Materials

- ❏ Journals
- ❏ Writing Utensils
- ❏ Sit Pads

Step 1

- Ask students, "Who likes to wander or sit in natural places?" "Does anyone keep a journal to record things they see, hear, and smell?" Encourage students to experiment with their sense of touch and to journal about the amazing old growth forest!
- Demonstrate a crow call, explain to the students that when they hear the crow call that they are to return back to the group.
- Distribute journals if the students do not already have them; also distribute pads for students to sit on.
- Establish ground rules: don't distract one another, stay on the path, stay quiet to hear the sounds of the woods.
- Allow students to spread throughout the area so that they cannot see or hear each other.
- Take 20 minutes to sit spot, actively monitoring behavior without being a distraction. *20 minutes based on suitable weather, if weather is not conducive to sit spotting suggest standing and making observations instead.

After 20 minutes, crow call to gather the students into a group to reflect on the journaling activity, ask students to share their "story of the day"